

The following is a brief description of Sysco San Francisco's Ammonia refrigeration system operation. A more detailed description of the system components and their operation and safety systems can be found in the CalARP/EPA Risk Management program.

SYSTEM DESIGN AND DESCRIPTION

The maximum intended inventory of ammonia at the Sysco San Francisco, Inc. facility is 16,500 pounds (3,300 gallons) within one refrigeration system.

OPERATION THEORY

The ammonia refrigeration system is a closed system that transforms the refrigerant, ammonia, from liquid to gas and back to a liquid. The system, consisting of vessels, piping, valves, and process equipment, transforms ammonia through various cyclical physical states (high pressure liquid, low pressure liquid, low pressure vapor, high pressure vapor, and then back to high pressure liquid) in order to provide refrigeration for product and process equipment.

Changes in pressure are directly related to changes in temperature: lowering the ammonia pressure lowers its temperature. Low pressure (cold) liquid ammonia provides refrigeration by removing ambient heat. Removal of ambient heat causes the liquid ammonia (contained within the system) to vaporize. Heat is later removed from the ammonia as it is condensed back into a liquid. Typical operating conditions range from approximately 1 psig on the low-pressure side of the system to 185 psig on the high side.

SYSTEM OPERATION AND DESIGN

Refrigeration process equipment at the facility operates continuously. Multiple compressors and condensers cycle on and off to comply with system demand during operation. The ammonia refrigeration system provides cooling for coolers, freezers and dock.

The refrigeration cycle begins with the transfer of high pressure liquid ammonia from the High Pressure Receiver (+90°) to the Controlled Pressure Receiver and Pilot Receiver. The Pilot Receiver supplies high-pressure liquid ammonia for thermosyphon oil cooling of the compressors. Excess liquid in the Pilot Receiver will drain to the Controlled Pressure Receiver via an overflow riser. The Controlled Pressure Receiver (+90°) serves as the main storage vessel for the system. It supplies high-pressure liquid ammonia to the High Temperature Recirculator (+15°). Ammonia in the High Temperature Recirculator is maintained at a constant temperature of 15°/28.4 psig via the suction pressure of the high stage compressors. The High Temperature Recirculator uses pumps to transfer low-pressure liquid ammonia to coolers and dock evaporators located in the cold warehouse including several cold zones (28°, 34°, 40°, and 50°). Air is blown across the evaporator coils with electric fans, transferring heat from the air to the liquid ammonia inside the coils, which partially vaporizes the liquid. The liquid/vapor mixture (suction) is returned to the High Temperature Recirculator where the liquid is recycled and the vapor is drawn away by the compressors.

The Low Temperature Recirculator (-20°) services similar but colder set of evaporators (-10°) using similar liquid pumps, etc. Ammonia in the Low Temperature Recirculator is maintained at a constant temperature of -20°/3.6 psig via the suction pressure of the low stage/booster compressors.

The Low Stage/Booster Compressors (B-1 & B-2) draw ammonia vapor from the Low Temperature Recirculator maintaining the vessel's pressure at the suction set point. The Low Stage/Booster Compressors increase the pressure of the low-pressure vapor and discharges higher-pressure vapor to the High Temperature Recirculator.

The High Stage Compressors (H-1 & H-2) work in combination to draw vapor from the High Temperature Recirculator and increase its pressure. The resulting high stage discharge (hot gas) is routed to the condensers, where fans and sprayed water are used to discharge the latent heat from the ammonia to the atmosphere, condensing it back into liquid. Hot gas is also used to assist in the defrost cycle of the evaporators and for the heating for the colder winter months. An auto purger removes non-condensable (i.e. air) from the system, and each vessel has mechanical pressure relief valves that automatically engage to vent high-pressure ammonia to an emergency dump tank.

Low Stage/Booster Compressor BC-2 is a swing compressor that can be changed to draw its suction from the high temperature recirculator when required.

The Hot Gas Reciprocating Compressor (HG-1) draws ammonia vapor from the High Temperature Recirculator. The reciprocating compressor then increases the ammonia vapor pressure and the resulting discharge is routed to the 50°F evaporators where it is used for hot gas defrost and heating in the winter months.

Ammonia piping is designed according to ASME B31.5 standards.

SAFETY SYSTEMS

All ASME vessels are equipped with pressure relief valves (PRV). The relief valves in the mechanical room are piped to a common header that vents to the emergency dump tank. An ammonia detector in the common relief header alerts operators that a relief valve has discharged. The pressure relief valves were installed and designed in accordance with ANSI/ASHRAE Standard 15 "Safety Standard for Refrigeration Systems" and ANSI/IIAR 2 "American National Standard for Equipment, Design, and Installation of Ammonia Mechanical Refrigeration Systems"

There is a Diffusion tank with a capacity of 1 gallon of water for each pound of ammonia that will be released in 1 hour from the largest relief device. The largest relief valve in the system has a capacity of 4,529 #’s of ammonia per hour and would require a Diffusion tank with a capacity of 4,529 gallons of water. Sysco San Francisco’s Diffusion tank is designed to hold 12,650 Gallons of water.

There will be an automatic crossover valve from the High Temperature Recirculation System to the Low Temperature Recirculation system. A pressure switch on the inlet side of the Automatic Crossover valve will cause the corresponding Automatic Crossover valve to open and relieve the excess pressure to the lower pressure zone before the pressure reaches within 90% of the relief valve setting. The Automatic Crossover valve can be manually opened via the ON/OFF switch

located in the Ammonia Emergency Pressure Control Panel to be installed near the Diffusion tank.

The High Temperature zone and the Low Temperature zone are designed for the same Maximum operating pressure of 150 psig. The Automatic Crossover valve will relieve at a pressure no higher than 135 psig and an automatic emergency stop feature is provided in accordance with Sections 606.10.2.1 and 606.10.2.2 of the California Fire Code.

All Compressors connected on the inlet side of the automatic crossover valve will shut down based on the set point (130 psig) of a dedicated pressure sensing device located immediately adjacent to the automatic crossover valve.

Ammonia sensors are located in key locations at the facility (machine room and evaporators). Sysco San Francisco, Inc. personnel circulate throughout the plant, taking note of unusual conditions in any portion of the system. If a leak is detected or observed by any employee (or contractor), it is immediately reported to their supervisor in order to take action to mitigate the leak.